Semantic web evolution

tectonic quake or gentle drift?

Jérôme Euzenat



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1992 Researcher at INRIA

- 2000 Started creating the semantic web ;-)
- 2012 Realised what we have done
- 2016 Fearing that it could break

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Outline

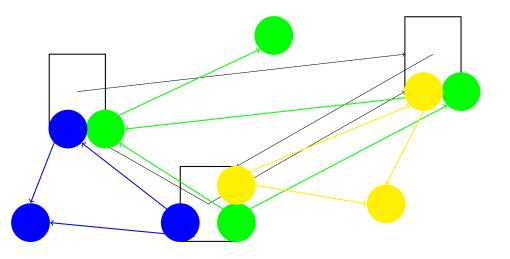
The semantic web is a success Why is evolution a problem? Addressing evolution

The semantic web is a success Gloria allegro (ma no troppo)

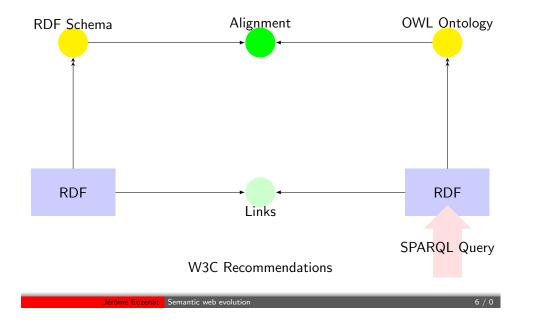
Why is evolution a problem? Lamento andante

Addressing evolution Vivace moderato

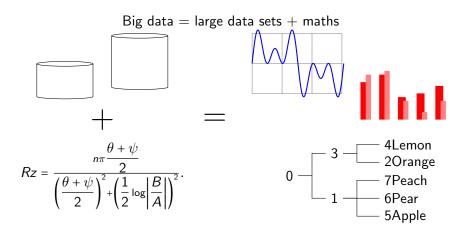




Why is evolution a probler Addressing evoluti



Big data without knowledge? The semantic web is a Why is evolution a pr Addressing ev



If this is not informed... the result will be: a plot!

Application of semantic web technologies:

- Semantic web services in which web services are semantically annotated;
- Semantic P2P systems in which shared resources are semantically annotated;
- Semantic social networks in which social relationships are semantically annotated;
- Ambient intelligence in which sensors, devices and information are semantically annotated;
- Linked data in which data is published with semantic web technologies;
- Smart cities in which city data is exchanged would benefit in using semantic web technologies.

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The semantic web is a success!

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Such technologies are used every day (by yourself).

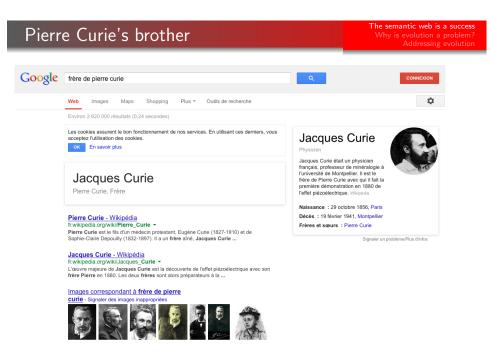
- Tens of billions of RDF triples and thousands of ontologies on the web;
- Governments and their agencies publish their data in RDF;
- Facebook (OG), Google (GKG), Yahoo, Microsoft (schema.org) produce and consume semantic markup.
- And you do not even have to notice it.

Marie Curie's daugthers

The semantic web is a success Why is evolution a problem?



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Marie Curie's husband	The semantic web is a success Why is evolution a problem? Addressing evolution
Web Images Maps Shopping Plus ~ Outils de recherche Environ 4.380 000 résultats (0,33 secondes) Es cookies assurent le bon fonctionnement de nos services. En utilisant ces demiers, vous acceptez l'utilisation des cookies. Got En savoir plus	CONNEXION CONNEXION Pierre Curie Physicien
Pierre Curie (m. 1895–1906) Marie Curie, Conjoint <u>Marie Curie - Wikipedia</u> fr.wikipedia.org/wiki/Marie_Curie - Pierre Curie - son épour - et Marie Curie reçolvent une motilé du prix Nobel Le	Pirre Curio est un physicien français. Il est principalement comu pour ses magnétisme adoactivité, en magnétisme at en piézoelectricité. Vitapolas Nalssance : 15 mai 1859, Paris Décés : 19 avril 1966, Paris Décés : 19 avril 1966, Paris Décés : 19 avril 1966, Paris
10 décembre 1903, Marie Curie reçoit avec son mari Pierre Curie et Henri Pierre Curie - Discussion:Marie Curie - Catégorie:Marie Curie Dates Marie Curie - L'Internaute www.linternaute.com > Dictionnaire ▼ Marie Skiodowska épouse Pierre Curie Maria Skiodowska porte désormais le nom de Marie Curie. Elle avait rencontré son mari l'année précédente. Tous deux Biographie Marie Curie - L'Internaute www.linternaute.com > Dictionnaire ▼	Découvertes : Radium, Polonium Parents : Sophie-Claire Depoulity Curie, Eugène Curie Recherches associées Warie Curie Marie Curie Henér Eugène Libér Curie Henér Eugène Libér Curie Henér Eugène Libér Curie
Marie Curie reste une grande figure ferminine du XXe siècle Ferme courage, la mort de Pierre Curie la poussée à poursuivre ses objectifs avec encore plus Images correspondant à mari de marie Curie - Signaler des images inappropriées	Becquerer Joint-Curre Joint-Curre



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I am a biologist looking to compare various available insulin products on the market

Semantic web evolution

Bio2RDF

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Drugbank in Bio2RDF

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ttp://bio2rdf.org/drugbank:DB0	00047	
nsulin Glargine [drugbank:DB00047]		
Subject	Predicate	Object
http://bio2rdf.org/drugbank:DB00047	http://bio2rdf.org /bio2rdf_resource:urlList	http://bio2rdf.org/html/drugbank:DB00047
	http://bio2rdf.org /drugbank_vocabulary:absorption	Forms microprecipitates following subcutaneous injection. Slow release of insulin glargine from microprecipitates provides a relatively constant concentration of insulin over 24 hours. Onset of action is approximately 1.1 hours.
	http://bio2rdf.org /drugbank_vocabulary:affected- organism	Humans and other mammals
	http://bio2rdf.org /drugbank_vocabulary:biotransformation	Partly metabolized to two active metabolites with similar <>in vitro activity to insulin: A21-Gly-insulin ar A21-Gly-des-B30-Thr-insulin.
	http://bio2rdf.org /drugbank_vocabulary:brand	Lantus
	http://bio2rdf.org /drugbank_vocabulary:category	Approved
		Biotech
		Hypoglycemic Agents
	http://bio2rdf.org /drugbank_vocabulary:ddi-interactor-in	http://bio2rdf.org/drugbank_resource:DB00047_DB00052
		http://bio2rdf.org/drugbank_resource:DB00047_DB00187
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		http://bio2rdf.org/drugbank_resource:DB00047_DB00373
		http://bio2rdf.org/drugbank_resource:DB00047_DB00489
		http://bio2rdf.org/drugbank_resource:DB00047_DB00521

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	http://bio2rdf.org/uspatent:7476652
http://bio2rdf.org /drugbank_vocabulary.pharmacology	Insulin is a natural hormone produced by beta cells of the pancreas. In non-flabetic individuals, a basal level of insulin is supplemented with insulin spikes following meals. Increased insulin secretion following meals is responsible for the metabolic changes that occur as the body transitions from a postabsorptive to absorptive state. Insulin promotes cellular tigake of gluccea, particularly in muscle and adjose tissues, promotes energy storage via glycogenesis, oppose catabolism of energy storage that of subscriptive synthesis by simulating ammo acti uplake by their muscle and adjose tissue, and molfies the activity of required for the actions of growth hormore (e.g. protein synthesis, cell division, DNA synthesis), Insulin glargine is a long-acting insulin analogue with a flat and predictable action profile. It is used to minic the basal levels of insulin in diabetic individuals. The onset of action of insulin glargine is approximately 90 minutes and its duration of action is up to 24 hours.
http://bio2rdf.org /drugbank_vocabulary:product	http://bio2rdf.org/drugbank_resource:0/81aa6a381c43d34e92b1c20e211482
	http://bio2rdf.org/drugbank_resource:4e6109c99e08e96f3e21c14e174e109d
	http://bio2rdf.org/drugbank_resource:562b8936d9ac1c47f39c097933706809
	http://bio2rdf.org/drugbank_resource:8303abbfbfe102fe6ec00f94de5e77fe
	http://bio2rdf.org/drugbank_resource:14214df5a11017a24067e672982163ed
http://bio2rdf.org /drugbank_vocabulary:synonym	Insulin Glargine (rDNA origin)
http://bio2rdf.org /drugbank_vocabulary:target	http://bio2rdf.org/drugbank_target:36
	http://bio2rdf.org/drugbank_target:958
http://bio2rdf.org /drugbank_vocabulary:toxicity	Inappropriately high dosages relative to food intake and/or energy expenditure may result in severe and sometimes protoragid and ill-intreatiening hypoghycemia. Neurogenic (autonomic) ejus and symptoms of hypoglycemia include trembling, palpitations, sweating, anxiety, hunger, nausea and tingling. Neuroglycopenic signs and symptoms of hypoglycemia include difficulty concentrating, lethragylyrealness, contraision, drowsiness, vision changes, difficulty speaking, headache, and dizcuess. Mid hypoglycemia is characterized by the presence of autonomic symptoms. Moderate hypoglycemia is characterized by the presence of autonomic symptoms. Moderate hypoglycemia is characterized autonomic and heuroglycopenic symptoms. Moderate hypoglycemia unconscious in severe cases of hypoglycemia. Other adverse events that may occur include allergic reaction, injection site reaction, lipodystrophy, puritis, and rash.
http://bio2rdf.org /drugbank_vocabulary:xref	http://bio2rdf.org/ahfs:68:20.08
	http://bio2rdf.org/ato:A10AE04
	http://bioOrdf.org/oppid/20227.0F.1

http://bioOrdf.org/opp.

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Drugbank in Bio2RDF (cont'ed)

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/drugbank_vocabulary:signals	
http://bio2rdf.org /drugbank_vocabulary:species	http://bio2rdf.org/taxon:9606
http://bio2rdf.org /drugbank_vocabulary:specific-function	This receptor binds insulin and has a tyrosine-protein kinase activity, Isoform Short has a higher affinity for insulin. Mediates the metabolic functions of insulin. A linding to insulin simulates association of the receptor with downstream mediators including IRS1 and phosphatidy/inositol 3-xinase (PI8K). Can activate PI3K either directly by binding to the p85 regulatory subunit, or indirectly via IRS1.
http://bio2rdf.org /drugbank_vocabulary:synonym	CD220 antigen
	EC 2.7.10.1
	IR
	Insulin receptor precursor
http://bio2rdf.org /drugbank_vocabulary:theoretical-pi	6.18
http://bio2rdf.org /drugbank_vocabulary:transmembrane- regions	957-979
http://bio2rdf.org /drugbank_vocabulary:xref	http://bio2rdf.org/genatlas:INSR
	http://bio2rdf.org/genbank:307070
	http://bio2rdf.org/genbank:M10051
	http://bio2rdf.org/genecards:INSR
	http://bio2rdf.org/hgnc:6091
	http://bio2rdf.org/hprd:00975
	http://bio2rdf.org/pfam:PF00041
	http://bio2rdf.org/pfam:PF00757
	http://bio2rdf.org/pfam:PF01030
	http://bio2rdf.org/pfam:PF07714
http://purl.org/dc/terms/rights	http://bio2rdf.org/uniprot:P06213 http://bio2rdf.org/license/drugbank_target:36
http://pun.org/dc/terms/rights http://rdfs.org/ns/void#inDataset	http://bio2rdf.org/bio2rdf_dataset:bio2rdf-drugbank-20121008
http://www.w3.org/1999/02/22-rdf-	http://bio2rdi.org/bio
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Jérôme Euzenat Semantic web evolution

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Taxa in Bio2RDF

The semantic web is a success Why is evolution a problem? Addressing evolution

man[taxon:9606]	at Bio2RDF Links Namespace	Find links in namespace Search
http://bio2rdf.org/taxon:9606		Find intranamespace linksFind global links
human[taxon:9606]		
taxon:9606		
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Homo sapiens[taxon:9606]		
Subject	Predicate	Object
http://bio2rdf.org/taxon:9606	http://bio2rdf.org/bio2rdf_resource:urlList	http://bio2rdf.org/html/taxon:9606
	http://bio2rdf.org/taxon_vocabulary:division	http://bio2rdf.org/taxon_resource:49afa3da97fcaa50e0f2464bb6af7b8f
	http://bio2rdf.org/taxon_vocabulary:embl_code	species
	http://bio2rdf.org /taxon_vocabulary:genbank_hidden_flag	1
	http://bio2rdf.org/taxon_vocabulary:genetic_code	http://bio2rdf.org/taxon_resource:c0b482c3147c6ffb2bc887e69239e244
	http://bio2rdf.org /taxon_vocabulary:hidden_st_root_flag	0
	http://bio2rdf.org /taxon_vocabulary:inherited_division_flag	1
	http://bio2rdf.org /taxon_vocabulary:inherited_gc_flag	1
	http://bio2rdf.org /taxon_vocabulary:inherited_mgc_flag	1
	http://bio2rdf.org /taxon_vocabulary:mitochondrial_genetic_code_id	2
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		cenbank common name

(No title found) at BIO2RDF http://bio2rdf.org/uniprot:P06213

Subject http://purl.uniprot.org /uniprot/P06213 (External link)

nd) at Bio2RDF	Inks Links Namespace (Find links in namespace) (Search
	Find intranamespace links
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http://put.uniprot.org/SH4-384 (023E60204F138E3F3603F9703F8178E4F9AAFF01DEE72EFC0C7AA10BCD4874BFE3F336637E13AB59F6D27A720101E8B (External link)
http://put.unincrd.org/SHA-384 (030107543035C4105FB670A4D53FB1C46E16C2E5118B4A49FB1A925101FA8CE37F2837608EC78A83408B11FEFD1E70635 (External link)
http://put/unincro.org/SHA-384 (0359866762135D21AC0491756EC1821B663799B3C374BD11C113BBDB2CA1AAF382D8102EB7C6E46F476B4141E1E3991 (External link)
http://put/uniprot.org/SHA-384 (09AD21C1628E15237B8B7CEA5C1563FDE03722428E5123E605EFFA4258668EDB3A0ADF7B40C16CCF066E1EB9A126C888 (External link)
http://put.unincd.org/SHA-384 (0A682071790546F8EAC69AE02B5916BD2BA0C97993F9B7927BB1EDFA00EC5759900C0214DFE7BACE3C6FD9057FC6028 (External link)
http://purt.uniprot.org/SHA-384 (AADE9738C750F42R3C9892B9D4840191DC06D8D3E91E91A685AB0E18485D043FEEEFEBB6B7E0727175D160B13C2AFD38 (External link)

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The semantic web is a success

Why is evolution a problem? Addressing evolution

The semantic web is a success

curl -L -H "Accept:application/rdf+xml"

=celarent.inrialpes.fr=49=> curl -L -H "Accept:application/rdf+xml" http://purl.uniprot.org/uniprot.	/P06213 more
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<pre><rdf:description rdf:about="http://purl.uniprot.org/uniprot/P06213"></rdf:description></pre>	
<pre><rdf:type rdf:resource="http://purl.uniprot.org/core/Protein"></rdf:type></pre>	
<pre><reviewed rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</reviewed></pre>	
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Protein names Gene names	Recommended name: Insulin receptor Short name=in EC=27 10.1 Alternative name(s): CD_antigen=CD220 Cleaved into the following 2 chains: 1. Insulin receptor subunit alpha 2. Insulin receptor subunit beta Name:INSR	
Organism	Homo sapiens (Human) [Reference proteome]	
Organism	nomo sapiens (numan) [nelerence proteonie]	
Taxonomic identifier	9606 [NCB]	

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Drugbank in Bio2RDF (dereferencing)

The semantic web is a success

=celarent.inrialpes.fr=48=> curl -L -H "Accept:application/rdf+xml" http://bio2rdf.org/drugbank_target:36 |more

% Total	% Received	1 % Xfen	i Avera	e Sneed	Time	Time	Time	Current		
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<pre>xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#" xmlns:ns0pred="http://purl.org/dc/terms/" xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"></pre>	
<pre>«rdf:Description rdf:about="http://bio2rdf.org/drugbank_target:36"></pre>	
<rdf:type rdf:resource="http://bio2rdf.org/drugbank_vocabulary:Target"></rdf:type>	
<pre><rdfs:label xml:lang="en">Insulin receptor [drugbank_target:36]</rdfs:label></pre>	
<pre><name xmlns="http://bio2rdf.org/drugbank_vocabulary:">Insulin receptor</name></pre>	
<pre><gene-name xmlns="http://bio2rdf.org/drugbank_vocabulary:">INSR</gene-name></pre>	
<signals xmlns="http://bio2rdf.org/drugbank_vocabulary:">1-27</signals>	
<pre><molecular-weight xmlns="http://bio2rdf.org/drugbank_vocabulary:">156308</molecular-weight></pre>	value
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<pre> wref xmlns="http://bio2rdf.org/drugbank_vocabulary:" rdf:resource="http://bio2rdf.org/pfam" wref xmlns="http://bio2rdf.org/pfam" wref xmlns="http://bio2rdf.org/drugbank_vocabulary:" rdf:resource="http://bio2rdf.org/pfam" wref xmlns="http://bio2rdf.org/drugbank_vocabulary:" rdf:resource="http://bio2rdf.org/drugbank_vocabulary:" rdf</pre>	
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(Security restrictions of this server do not allow you to retrieve remote RDF data, see details.) (HTML 🛟

 \checkmark Strict checking of void variables

0

(The result can only be sent back to browser, not saved on the server, see details)

Bio2RDF Resources

PUBLIC bio2rdf / bio2rdf-scripts

Home Pages History

Bio2RDF Release 2 (Jan 2013) Features:

• 1 billion triples across 19 updated datasets

· IRI normalization through a common dataset registry

· dataset statistics to describe intra and inter dataset connectivity.

· downloadable content RDF files and full text-indexed Virtuoso triple stores

Home

Bio2RDF Resources:

Query ext SELECT Thame ?target WHERE (?drug <http://bio2rdf.org/drugbank_vocabulary:target> ?target. ?targgt <http://bio2rdf.org/drugbank_vocabulary:species> <http://bio2rdf.org/taxon:9606>. ?targgt <http://bio2rdf.org/drugbank_vocabulary:xref> <http://bio2rdf.org/uniprot:P06213>. /drug dfdf.labal ?name

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GitHub This repository - Search or type a command ③

heterogeneously formatted sources obtained from multiple data providers.

milliseconds (values less than 1000 are ignored)

Explore Features Enterprise Blog

Bio2RDF is an open-source project that uses Semantic Web technologies to build and provide the largest network of Linked Data for the

Life Sciences. Bio2RDF defines a set of simple conventions to create RDF(S) compatible Linked Data from a diverse set of

• updated, MIT licensed scripts available for any use (including commercial use), modification and redistribution.

· dataset provenance to inform a user of what version of data they are using and how it was generated.

• public CORS-enabled SPARQL 1.1 endpoints for faceted search and federated SPARQL queries

Default Data Set Name (Graph IRI)

Query Text

Results Format:

Options:

Execution timeout:

(Run Query) (Reset)

The semantic web is a success

About | Namespace Prefixes | Inference rules | iSPARQI

name	target
drug-target interaction Insulin Lispro and Insulin receptor [drugbank_resource:DB00046_36]	http://bio2rdf.org /drugbank_target:36
"Insulin Glargine [drugbank:DB00047]"@en	http://bio2rdf.org /drugbank_target:36
"Insulin, porcine [drugbank:DB00071]"@en	http://bio2rdf.org /drugbank_target:36
Insulin recombinant [drugbank:DB00030]"@en	http://bio2rdf.org /drugbank_target:36
drug-target interaction Insulin recombinant and Insulin receptor [drugbank_resource:DB00030_36]	http://bio2rdf.org /drugbank_target:36
"Insulin Lispro [drugbank:DB00046]"@en	http://bio2rdf.org /drugbank_target:36
"Insulin Aspart [drugbank:DB01306]"@en	http://bio2rdf.org /drugbank_target:36
"Insulin Glulisine [drugbank:DB01309]"@en	http://bio2rdf.org /drugbank_target:36
drug-target interaction Insulin Glargine and Insulin receptor [drugbank_resource:DB00047_36]	http://bio2rdf.org /drugbank_target:36
'Insulin Detemir [drugbank:DB01307]*@en	http://bio2rdf.org /drugbank_target:36
drug-target interaction Insulin, porcine and Insulin receptor [drugbank_resource:DB00071_36]	http://bio2rdf.org /drugbank_target:36
"Mecasermin [drugbank:DB01277]"@en	http://bio2rdf.org /drugbank_target:36
drug-target interaction Mecasermin and Insulin receptor [drugbank_resource:DB01277_36]	http://bio2rdf.org /drugbank_target:36

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404	The semantic web is a success Why is evolution a problem? Addressing evolution



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The semantic web is a success

Sign in

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Page History Clone URL

Problems with links

Why is evolution a problem?

Network of ontologies

- ▶ The web relies on a robust design: links can break (404), but Human can cope.
- Nowadays... it is not clear that this is true anymore (think API changes). Quite some web site do not fail safely.
- With the semantic web, made for machine, the problem worsen (404 in your city... they call it a traffic jam).

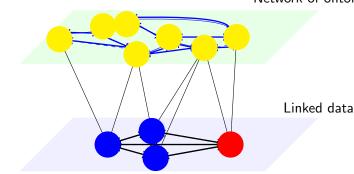
Semantic web evolution Problems with knowledge: ways it could break

Why is evolution a problem?

- incorrect property in data;
- incorrect subclass relation in ontology;
- incorrect membership assertion between instance and class;
- incorrect sameAs link between data;
- incorrect correspondence in alignments;

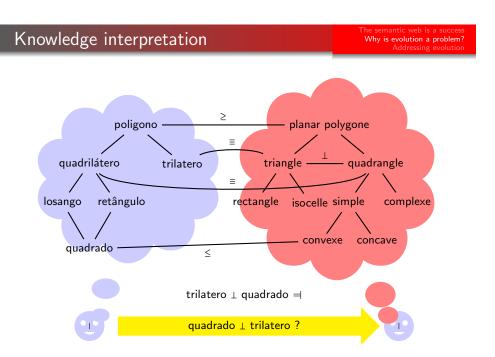
....

Hence, the question is not if it will break, but what to do then. Remember all this is decentralised and distributed.



- From ontology alignments to linked data;
- From linked data to ontology alignments;
- More local inference (composition);
- Reasoning;
- Repairing, trusting, learning;

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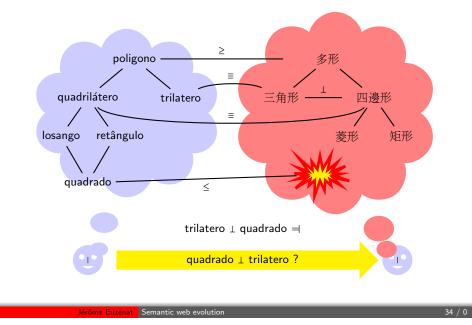
Jérôme Euzenat Semantic web evolution

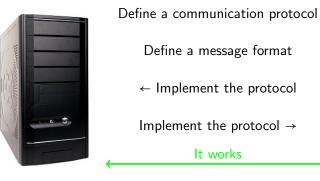
33 / 0

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Why is evolution a problem?

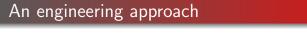
Why is evolution a problem?





Jérôme Euzenat	Semantic web evolution	35 / 0
Solutions?		The semantic web is a success Why is evolution a problem? Addressing evolution

- Freeze everything
- Track everything (ensure that everything is correct beforehand)
- Let things fail and repair them





We have lost adaptation capabilities

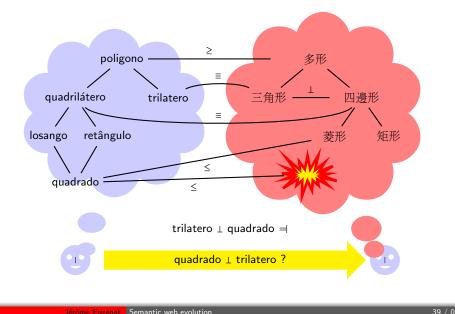
A living web

Addressing evoluti

- Preserving decentralisation, distribution and diversity
- Accepting changes
- i.e., Breaking with the engineering approach
- Taking inspiration from how societies evolve

From the ontology matching standpoint:

- Going from "Match first, then communicate"
- To: "Try to communicate, and if it breaks match"



Semantic web evolution

Cultural evolution

Semantic web evolution

Addressing evolution

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Experimental cultural evolution

Addressing evolut

Comes from anthropology (and population genetics)

Applies evolution theory to culture:

- Culture is an "intellectual artefact"
- which is transmitted (from generation to generation but not exclusively)
- which can be subject to selection.

- Pioneered by Robert Axelrod
- Applies multi-agent simulation to cultural artifacts
- Successfully applied to natural language by Luc Steels and colleagues
- Offers a systematic experimentation framework in which agents play "games"

Why is evolution a problem? Addressing evolution

Combining

Knowledge representation

and

experimental cultural evolution

for continuous knowledge evolution

- Take alignments as culture (not necessarily ontologies):
- Have agents try to communicate using available alignments;
- Let them repair them on the fly.

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Knowledge game setting

e semantic web is a succes /hy is evolution a problem <u>Addressing evolutio</u>

Environment populated by objects characterised by *n* dimensions: \blacksquare , \triangle , \square , \triangle , \blacksquare , \triangle , \square , \triangle .

Population *n* agents with their own representations (ontologies)

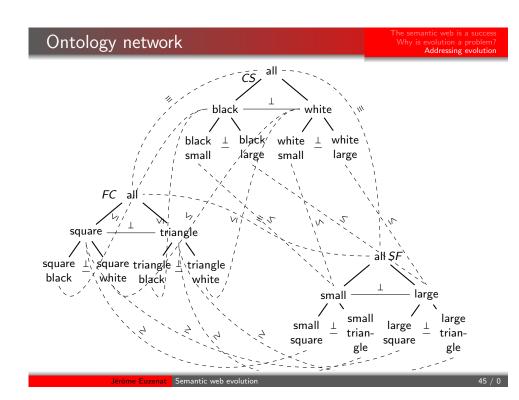
Semantic web evolution

Initialisation randomly generated alignments between their representations

- Game an agent draws randomly an object and ask to another (randomly selected) agent to which class it belongs. The former agent uses the alignments for determining to which class the entity belongs in his own ontology.
- Success the resulting class subsumes the class of the object
- Failure the class is disjoint (exclusive)
- Repair (a) suppress the correspondence; (b) replace it by a weaker correspondences; (c) add an entailed correspondence.

Secondary measure (Semantic) F-measure

External evaluation Compare to Alcomo, LogMap



Alignment repair game

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large

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Addressing evolution

large

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large

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Why is evolution a problem Addressing evolution

all

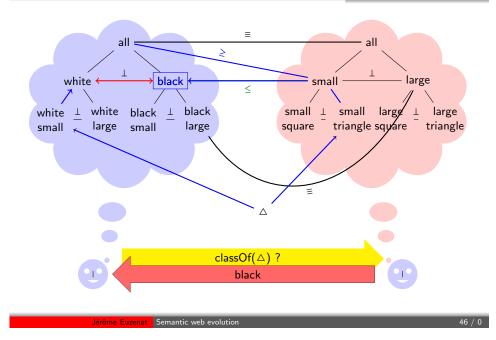
square _ triangle square _ triangle

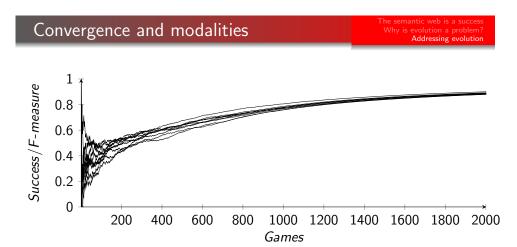
small

small ⊥ small larg∉

Alignment repair game

Addressing evolu





modality=add; #agents=4; #games=2000; #runs=1

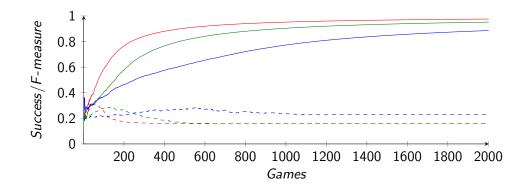
1. Does the process converge?

Experimental questions

- 2. What is the effect of repair modalities?
- 3. How does this compare to baselines?
- 4. Does it scale?

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modality=del,repl,add; #agents=4; #games=2000; #runs=10deldelrepladdaddsuccess rateF-measuresuccess rateF-measureF-measure

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Scalability

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		Inco	bher	enc	ce	F-measure				
	# agents	Initial	LogMap	Alcomo	Final	Initial	LogMap	Alcomo	Final	Convergence
	3	0.31	0.	0.	0.	0.32	0.35	0.36	0.33	300
	4	0.47	0.	0.	0.	0.20	0.24	0.25	0.21	1670
	5	0.58	0.	0.	0.	0.11	0.18	0.17	0.24	5400
	6	0.63	0.	0.	0.	0.06	0.12	0.11	0.14	10.000 +

modality=add; #agents=3,4,5,6; #games=10000; #runs=10

		Success	Incoherence	Semantic	Syntactic	
Modality	Size	rate	degree	F-measure	F-measure	Convergence
reference	70	-	0.0	1.0	1.0	-
initial	54	-	[0.46-0.49]	0.20	(0.20)	-
delete	6	0.98	0.0	0.16	(0.16)	400
replace	6	0.95	0.0	0.16	(0.16)	1000
add	12.7	0.89	0.0	0.23	(0.16)	1330
Alcomo	25.5	-	0.0	0.26	(0.14)	-
LogMap	36.5	-	0.0	0.26	(0.14)	-

modality=del,repl,add; #agents=4; #games=2000; #runs=10

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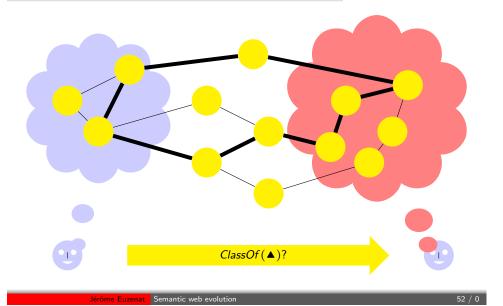
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Problem solving vs. survival

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- The number of games for converging (reaching perfect communication) grows fast (with n);
- Indeed the probability of finding, at random, the last failure is really low;
- It is possible to produce an algorithm that converges faster:
- But this is *not* the problem
- Their goal is not to solve a problem, but to live
- How many more do you think it will take you to reach perfect communication with your closest relatives?

Considering agents having each their own network of ontologies



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Wrap-up

Addressing evolution

- The semantic web is a success (and you need it)
- It can easily break due to the world evolving
- But the world is evolving (you will not stop that)
- So our design should be prepared to that
- Cultural evolution seems and appropriate inspiration

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